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RUNNING TITLE: Adaptive Functioning Impairments in ASD

Title: Investigating the Factors Underlying Adaptive Functioning in Autism in the EU-AIMS
Longitudinal European Autism Project

Running title: Adaptive Functioning Impairments in ASD

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Lay summary

This study investigated key clinical and demographic associations of adaptive functioning impairments in individuals with autism. We found that older age, lower IQ and more severe social-communicative symptoms, but not sensory or repetitive symptoms or co-occurring psychiatric symptoms, are associated with lower adaptive functioning and greater ability-adaptive function discrepancies. This suggests that interventions targeting adaptive skills acquisition should be flexible in their timing and intensity across developmental periods, levels of cognitive ability and take account of social-communicative ASD symptom severity.

Scientific Abstract

Individuals with autism spectrum disorder (ASD) exhibit significant impairments in adaptive functioning that impact on their ability to meet the demands of everyday life. A recurrent finding is that there is a pronounced discrepancy between level of cognitive ability and adaptive functioning, and this is particularly prominent among higher-ability individuals. However, the key clinical and demographic associations of these discrepancies remain unclear. This study included a sample of 417 children, adolescents and adults with ASD as part of the EU-AIMS LEAP cohort. We examined how age, sex, IQ, levels of ASD symptom and autistic trait severity and psychiatric symptomatology are associated with adaptive functioning as measured by the Vineland Adaptive Behavior Scales-Second Edition and IQ-adaptive functioning discrepancies. Older age, lower IQ and higher social-communication symptoms were associated with lower adaptive functioning. Results also demonstrate that older age, higher IQ and higher social-communication symptoms are associated with greater IQ-adaptive functioning discrepancy scores. By contrast, sensory ASD symptoms, repetitive and restricted behaviours, as well as symptoms of attention deficit/hyperactivity disorder (ADHD), anxiety and depression, were not associated with adaptive functioning or IQ-adaptive functioning discrepancy scores. These findings suggest that it is the core social communication problems that define ASD that contribute to adaptive function impairments that people with ASD experience. They show for the first time that sensory symptoms, repetitive behaviour and associated psychiatric symptoms do not independently contribute to adaptive function impairments. Individuals with ASD require supportive interventions across the lifespan that take account of social-communicative ASD symptom severity.

Keywords: autism spectrum disorder, adaptive functioning, intellectual functioning, symptom severity, psychiatric symptoms

Introduction

The term ‘adaptive behaviour’ refers to general societal expectancies about everyday functioning. In autism spectrum disorder (ASD), the Vineland Adaptive Behavior Scales (VABS; Sparrow et al., 1984; VABS-II; Sparrow et al., 2005) has often been used to assess adaptive functioning in socialisation, communication, self-care, and life skills for personal independence and community living, as well as motor skills in individuals aged up to 6 years. VABS domains assessed map well to the core ASD symptoms of socialisation and communication, as well as relevant measures of activities of daily living.

In ASD there is wide heterogeneity in the level of functioning across these domains, which is partly linked to development and level of cognitive abilities (Szatmari et al., 2015; Bal et al., 2015; Chatham et al., 2018; Farmer et al., 2018). Although higher intellectual functioning is typically associated with better adaptive functioning, adaptive behaviour tends to be more impaired than what would be expected based on general intellectual and cognitive ability (Bölte et al., 2002; Klin et al., 2007; Charman et al., 2011; Kanne et al., 2011; Mouga et al., 2015; Chatham et al., 2018). The discrepancy between level of adaptive behaviour and general intellectual level is particularly pronounced in individuals with ASD who have average or above average levels of cognitive functioning, where adaptive behaviour has been found to lag one to two standard deviations behind IQ (Klin et al., 2007; Charman et al., 2011; Kanne et al., 2011; Kraper et al., 2017). In contrast, individuals with ASD and concurrent intellectual disabilities are more likely to exhibit adaptive behaviour skills that are on par with or above their intellectual level (Bölte et al., 2002; Perry et al., 2009). Cross-sectional and longitudinal studies also indicate that this discrepancy widens with age (Szatmari et al., 2009; Smith et al., 2012; Bal et al., 2015), suggesting that individuals with ASD are not acquiring adaptive skills at the same rate as their typically developing peers (Klin et al., 2007; Mouga et al., 2015). Thus, despite having the necessary verbal and

nonverbal processing skills, many individuals with higher intellectual abilities have difficulty translating their cognitive potential into functional independence. Adaptive functioning has been shown to be an important determinant of outcome in individuals with ASD (Farley et al., 2009), including educational attainment (De Bildt et al., 2005) and the level of independence that an individual can achieve in adulthood (Paul et al., 2004). Identifying the factors that impede adaptive skill acquisition is therefore of great importance in planning more effective interventions to improve long-term outcomes. Yet, beyond age and IQ, relatively little is known about the role of ASD core and associated psychiatric symptom severity in the magnitude of adaptive-ability discrepancies. Identifying which specific aspects of the ASD phenotype, i.e. social-communicative symptoms, repetitive and restricted behaviours, or sensory symptoms, and how commonly associated psychiatric symptoms (e.g. ADHD, anxiety, depression) are associated with adaptive functioning, could provide novel insight into unique contributions to variability in adaptive functioning and inform specific intervention programmes.

The few existing studies addressing this issue have however produced inconclusive results. Ashwood et al. (2015) found greater discrepancies between IQ and adaptive behaviour, particularly in relation to social adaptive skills, in children with ASD and comorbid ADHD compared to an ADHD-only group when controlling for age. Krapar et al. (2017) in a sample of cognitively able adults with ASD found that greater IQ-adaptive discrepancies were associated to a small-to-moderate degree with more severe symptoms of depression and anxiety and social-communicative symptoms characteristic of the ASD phenotype, but not ADHD-related symptoms. Duncan et al. (2015) observed that the presence vs. absence of a daily living skills deficit in relation to IQ in adolescents with ASD was only significantly related to older age and higher level of current social-communicative symptoms on the Autism Diagnostic Interview – Revised (ADI-R; Rutter et al., 2003). Other predictor

variables, including IQ, parent-reported restrictive and repetitive behaviours (RRB), overall clinician-rated ASD symptoms as measured by the Autism Diagnostic Observation Schedule (ADOS-2; Lord et al., 2012), and internalising and externalising problem behaviours, were not associated with a higher likelihood of exhibiting a deficit. In addition to the relative lack of research in this area, methodological differences between studies further limit the generalisability of these findings, including small sample sizes, and limited age and IQ ranges studied. Further to this, only a few studies have simultaneously entered potential associated variables in regression models to contrast independent effects of specific aspects of the ASD phenotype and symptoms of associated psychiatric conditions.

The current study

To overcome some of these previous limitations, we tested unique predictors of adaptive functioning as measured by the VABS and the discrepancy between IQ and adaptive functioning in a well-characterised sample of individuals with ASD as part of the EU-AIMS Longitudinal European Autism Project (LEAP) cohort (Charman et al., 2017; Loth et al., 2017). LEAP includes participants across a broad age range from young children to adults and of different intellectual functioning. In this cohort we have comprehensive assessments not only of ASD symptoms using observational and questionnaire measures but also measures of common co-occurring psychiatric symptoms: ADHD, anxiety and depression. Based on previous studies, we expected to find a larger IQ-adaptive behaviour discrepancy in older individuals and in individuals with higher IQs. Furthermore, we predicted that severity of core ASD symptoms would be associated with greater adaptive function impairments and IQ-adaptive functioning discrepancies. We also tested whether co-occurring psychiatric symptoms would be associated with greater adaptive function impairments and IQ-adaptive functioning discrepancies above and beyond age and IQ and ASD symptoms. Previous studies have been lacking in the size of the samples studied (i.e. not ‘broad’) and the level of

clinical characterisation in relation to psychiatric symptoms (i.e. not ‘deep’). In addition, few have tested potentially associated variables simultaneously in regression models. Given the scarcity of comprehensive studies, we did not generate a priori predictions in relation to the influence of co-occurring psychiatric symptoms on adaptive behaviour.

Methods

Participants

The sample consists of 417 participants with ASD ranging in age from 6-31 years ($M=16.9$, $SD=5.95$, $IQR=9.12$) recruited as part of LEAP. Details of the study procedure, protocol, as well as inclusion/exclusion criteria and demographic and clinical characteristics of the cohort have been described elsewhere (Charman et al., 2017; Loth et al., 2017). Descriptive statistics for the sample are listed in Table 1. Full-Scale IQ (FSIQ) scores were available for 410 participants (98% of the sample) and ranged from 40 to 148, with a mean of 96.6 ($SD=20.27$). At each site an independent ethics committee approved the study. All participants (where appropriate) and/or their parent/legal guardian provided written informed consent.

- Table 1 about here -

Measures

Adaptive functioning was measured using the VABS (VABS-II; Sparrow et al., 2005). The VABS is a semi-structured parent interview that assesses adaptive functioning across three domains in >6-year-olds: Communication, Socialisation, and Daily Living Skills. For each domain, standard scores were obtained and combined to generate an Adaptive Behavior Composite (ABC) score. VABS standard scores have a mean of 100 ($SD=15$), with lower scores indicating greater functional impairment.

General intellectual abilities were assessed using the *Wechsler Abbreviated Scales of Intelligence-Second Edition* (WASI-II; Wechsler, 2011), or if unavailable the *Wechsler Intelligence Scale for Children-III/IV* (WISC-III/IV; Wechsler, 1991, 2003) for children or *Wechsler Adult Intelligence Scale for Adults-III/IV* (WAIS-III/IV; Wechsler, 1997, 2008) for adults (see Charman et al. 2017 for a detailed description of IQ measures). Standardised estimates of verbal IQ (VIQ), performance IQ (PIQ), and full-scale IQ (FSIQ) were derived using IQ norms with $M=100$ and $SD=\pm 15$.

The *Autism Diagnostic Observation Schedule* (ADOS-G; Lord et al., 2000; ADOS-2; Lord et al., 2012) is a semi-structured, clinician-administered instrument to evaluate aspects of social communication and interaction, stereotyped behaviours and restricted interests (see Supplementary Materials for additional information). ADOS-2 algorithm totals can be used to derive a Calibrated Severity Score (CSS) for the core symptom domains of Social Communication (i.e. Social Affect), and Restricted and Repetitive Behaviours (RRB), as well as an overall indicator of ASD severity (CSS Total). The CSS ranges from 1 to 10, with higher scores indicating more severe ASD symptom severity.

The *Social Responsiveness Scale, Second Edition* (SRS-2; Constantino et al., 2012) is a quantitative measure of ASD traits and is composed of 65 items. Here we report parent-report scores for total raw scores. The *Repetitive Behavior Scale-Revised* (RBS-R; Bodfish et al., 2000), composed of 43 items, was used to derive parent-reported total raw scores for restricted and repetitive behaviours relevant to the ASD phenotype, with higher scores indicating a greater level of atypical behaviours. Sensory processing atypicalities were assessed using the *Short Sensory Profile* (SSP; Tomchek et al., 2007) across 38 items, from which a total raw score was obtained (lower scores indicate more impairment) that reflect dysfunction across multiple sensory domains.

The *DSM-5 ADHD rating scale* provides on the basis of 18 items two separate scales for symptoms of inattention and hyperactivity/impulsivity following DSM-5 (American Psychiatric Association, 2013) criteria for ADHD, with higher scores indicating greater ADHD-related problems. Psychiatric symptoms of anxiety and depression were measured using the *Development and Well-Being Assessment* (DAWBA; Goodman et al. 2000), a semi-structured parent/carer interview designed to generate prediction scores for ICD-10 (World Health Organization, 1992) and DSM-IV-TR (American Psychiatric Association, 2000) psychiatric diagnoses. DAWBA scores reflect six levels of predication (i.e. from ~0.1% to >70%) of the probability of meeting clinically relevant diagnostic criteria for a disorder, ranging from very unlikely to probably. To facilitate comparisons and following Angold et al. (2012), we created a pooled anxiety prediction score reflecting an individual's highest risk score across a group of anxiety disorders (OCD, generalised anxiety, panic disorder, agoraphobia, PTSD, separation anxiety, social phobia, and specific phobia). For depression, the DAWBA generates a prediction score for major depression according to DSM-IV and ICD-10 criteria.

Data analysis

Statistical analyses were conducted using STATA software 15.0 (StataCorp, 2017). Linear mixed effects models were used to test predictors of domain scores (Communication, Socialisation, Daily Living) and ABC composite scores. A random effect for site was included to take into consideration the multi-level nature of the data and account for heterogeneity across sites. Estimates of total within-site variance were obtained via the 'mlt package' which computes R^2 values for multilevel models according to Snijders et al. (1994). This affords to separately estimate the amount of variance explained at the within-site (Level 1) and between-site level (Level 2). The magnitude of an adaptive functioning deficit relative to intellectual ability was determined by calculating for each individual FSIQ-adaptive

functioning difference scores separately for VABS Domain (Socialisation, Communication, Daily Living Skills) and Composite Scores (ABC). Participants with ASD were split into two groups depending on whether the magnitude of their FSIQ-VABS ABC discrepancy (FSIQ-VABS ABC) exceeded 15 standard score points (i.e. at least 1 *SD*), which according to the VABS manual (Sparrow et al. 2005), indicates a marked and clinically important discrepancy between an individual's cognitive ability and overall adaptive functioning skills. Analyses on IQ-adaptive discrepancy scores were restricted to individuals who had an FSIQ-VABS ABC impairment as defined above, which included 71% of participants of the total sample (263 of 369). These participants displayed on average a FSIQ-VABS ABC difference score that exceeded 2 *SDs* ($M=35.41$, 95% CI [33.8; 37.0], $SD=13.19$; Range=15 – 78). An analysis on the full sample (i.e. $N=369$), i.e. including those without clinically significant discrepancies between IQ and adaptive behaviour, can be found in Supplementary Table 3. Multivariate Multiple Regression (MMR) was conducted on IQ-adaptive discrepancy scores to take into account the possible inter-dependency among VABS outcome variables. To account for mathematical coupling between FSIQ and discrepancy scores, correlation coefficients were adjusted using Oldham's method (Oldham, 1962) and regression coefficients are reported for illustrative purposes only. To assess the effect of FSIQ on FSIQ-VABS discrepancy scores in this sub-sample, a separate non-mathematically-coupled MMR on VABS scores was conducted and included the linear and quadratic effect of FSIQ, as well as all covariates. This allowed to assess whether the linear effect of FSIQ depends on FSIQ itself (i.e. the quadratic effect) and gives accurate estimates of the function relating FSIQ and VABS. The same set of predictors were included for both linear mixed effects models and MMR: age, sex, FSIQ, ASD symptomatology (ADOS CSS Social Affect and CSS RRB, SRS-2, RBS-R, SSP) and symptoms of associated psychiatric conditions (ADHD inattentiveness and

hyperactivity/impulsivity, anxiety, depression). To increase confidence in the robustness of the results obtained, an α -level of $< .01$ was applied for all statistical analyses.

Results

Individuals with ASD demonstrated substantial impairments in adaptive behaviour across all domains on standardised VABS scores (age-normed reference value: $M=100$, $SD=15$). The most impaired adaptive behaviour domain was Socialisation, followed by Daily Living and the least impaired domain being Communication (Table 1; see Supplementary Materials for additional analyses and information on statistics and effect sizes). While there was great variability in VABS scores, domain and composite scores generally showed a pattern of greater adaptive functioning deficits with age (see Figure 1). This was also reflected in significant but weak negative correlations between age and VABS domains (Socialisation, Communication) and ABC scores (Supplementary Table 1; r from $-.19$ to $-.29$, all p 's $< .001$). Splitting individuals with ASD and without ID across three age groups (children, adolescents and adults), children (Age 6 to 11 years: $M=77.98$, 95% CI [75.19;80.76], $SD=12.98$) had on average higher scores than adolescents (Age 12 to 17 years: $M=68.76$, 95% CI [67.11;70.41], $SD=9.83$) and adults (Age >18 years: $M=67.17$, 95% CI [64.23;70.11], $SD=18.00$). Site differences for adaptive functioning ranged from minimal for the Socialisation and Communication (Intra-class correlation coefficient (ICC) = .14 and .06 respectively) to moderate for the Daily Living domain (ICC = .22) and ABC (ICC = .10).

- Figure 1 about here -

Full-scale IQ and VABS scores showed a significant moderate positive correlation, with higher IQ scores being associated with higher levels of adaptive functioning (Supplementary Table 1; r from .38 to .53, all p 's $< .0001$). There was also some evidence of a curvilinear association (Figure 2), such that the positive relationship between IQ and adaptive behaviour becomes shallower at higher IQ levels. While this was particularly the

case for the Daily Living and Socialisation domain, it was least pronounced for the Communication domain, where the relationship between IQ and adaptive behaviour appeared to follow a linear trend more closely. To test for this statistically, MMR models included both linear and quadratic terms for FSIQ and run for all VABS scores.

Testing all four equations simultaneously, the results revealed that the joint significance of the quadratic terms approached significance ($F_{(4,366)} = 3.01, p = .018$). Further exploratory individual comparisons for each VABS score and adopting a multiple comparison adjusted α -level revealed that the quadratic term was only significant for Daily Living ($p = .008$), but not the other domains (all p 's $> .054$).

- Figure 2 about here -

Predictors of adaptive functioning

Results for linear mixed effects models are summarised in Table 2. Across VABS scores, the overall model was significant (Wald $\chi^2_{(17)} > 130.57, p < .0001$), with the proportion of variance accounted for ranging from 36% to 46% for VABS domains and 45% for the ABC score. With the exception of the Daily Living Skills domain, age was a significant predictor across VABS ABC and domain-level scores (all p 's $< .001$), with the expected negative association (i.e. lower VABS scores with older age, see Figure 1). There was also a significant effect of FSIQ on VABS domain and composite scores (all p 's $< .005$), with higher IQ being associated with better adaptive functioning (see Figure 2). There were no significant sex differences in adaptive behaviour. For ASD symptom measures, higher SRS-2 raw scores were associated with greater adaptive functioning deficits across domain and composite scores (all p 's $< .002$). No associations with adaptive functioning were found for ASD symptoms based on observation (ADOS), as well as restricted and repetitive behaviours

(RBS-R) and sensory symptoms (SSP). Similarly, psychiatric symptom measures were not significantly associated with VABS domain or ABC composite scores.

- Table 2 about here -

Discrepancy between intellectual ability and adaptive functioning

Figure 3 highlights the heterogeneity in the magnitude of FSIQ-VABS ABC discrepancy scores as a function of age in the sample. On the MMR, there were significant effects of age (all p 's < .001) across VABS domain and composite scores (with the exception of age for FSIQ-Daily Living discrepancy scores; Table 3), with older age predicting larger discrepancy scores.

- Figure 3 about here -

Age-related differences in FSIQ-VABS ABC discrepancy scores were however modest, with children (Age 6 to 11 years: $M=27.97$, 95% CI [24.21;31.72], $SD=17.29$) having on average lower discrepancy scores than adolescents (Age 12 to 17 years: $M=30.07$, 95% CI [24.84;33.29], $SD=16.51$), who in turn had lower discrepancy scores than adults (Age >18 years: $M=33.34$, 95% CI [30.31;36.37], $SD=16.40$). Sex-related comparisons were not significant. In relation to ASD symptom measures, higher SRS-2 raw scores were significantly associated with greater discrepancy scores on the Socialisation domain ($b=.26$, $p < .001$) and ABC ($b=.17$, $p < .001$), and was approaching significance for Daily Living Skills ($b=.13$, $p = .021$) and the Communication domain ($b=.13$, $p = .015$). There was no significant effect of RRB or sensory symptoms on FSIQ-adaptive functioning discrepancy scores. Psychiatric symptom measures were also not significantly associated with FSIQ-VABS discrepancy scores. When analysing the full sample of participants, i.e. including those with a FSIQ-VABS ABC discrepancy of less than 15 standard score points, the same pattern of effects was observed (see Supplementary Table 3). In line with the expected positive association between FSIQ and FSIQ-VABS discrepancy scores (Supplementary Table 2), the

non-mathematically-coupled MMR on VABS scores revealed significant linear and quadratic effects of FSIQ on the Daily Living domain ($b_{linear}=2.13, p = .003; b_{quadratic}=-.008, p =.013$) and ABC ($b_{linear}=1.71, p = .001; b_{quadratic}=-.006, p =.01$) and was approaching significance on the Socialisation domain ($b_{linear}=1.52, p = .032; b_{quadratic}=-.006, p =.078$).

Discussion

This study is the first to-date to comprehensively assess how different aspects of the ASD phenotype and associated psychiatric symptoms are associated with adaptive behaviour and ability-adaptive discrepancies in ASD. The findings show that it is social-communicative symptoms, but not sensory or repetitive symptoms or co-occurring psychiatric symptoms including anxiety, depression and ADHD that are associated with lower adaptive functioning and greater ability-adaptive function discrepancies. To further deconstruct these relationships at different levels of measurement (i.e. clinician-rated, parent-rated questionnaires) and across different domains of impairment, the ADOS, a well-established diagnostic measure, was administered alongside a measure of autistic traits severity (SRS-2) as well as specific measures of repetitive (RBS-R) and sensory symptoms (SSP). A clear pattern of findings emerged, whereby more severe parent-rated social symptoms (SRS-2) were predictive of both lower adaptive functioning scores (across domain and composite scores) and greater IQ-adaptive functioning discrepancy scores (Socialisation domain and composite scores), while observer ratings of ASD symptoms (ADOS-2) and parent-rated sensory symptoms and RRB were not. Overall, these findings suggest that social aspects of the ASD phenotype, at least as captured by parent-report trait measures, are critical factors in mediating the acquisition of adaptive competencies in real life situations. Social impairments across the lifespan may impede appropriate development of adaptive behaviour skills by changing the experience of

the environment and further restricting opportunities for learning in naturalistic settings. However, this does not imply that sensory symptoms and RRB, as well as symptoms of associated psychiatric conditions should be overlooked when designing interventions targeting adaptive skill acquisition. In fact, the correlational analysis highlighted small to moderate associations between sensory symptoms, RRB, associated psychiatric symptoms and adaptive functioning in ASD. When entered simultaneously in a regression model with other associated variables, these associations were however not significant. A recent longitudinal study also suggests that within individuals, the relationship between ASD symptoms and adaptive behaviour over time is more complex than observed here, such that there exists only a small amount of “yoking” of developmental trajectories between these two constructs (Szatmari et al., 2015). In other words, some individuals with more severe but stable ASD symptoms may show marked improvements in adaptive skills, reflecting their potential to acquire developmentally-appropriate adaptive skills (Szatmari et al., 2015). As the EU-AIMS LEAP cohort will be followed into the future, we will be able to address a range of these complex interactions in more detail.

Of note is that SRS-2 scores, based on parent-report, showed the strongest association with Vineland scores, which were also parent-reported. It is therefore possible that shared method variance, i.e. the fact that the two measures share the same reporting method, may partially account for the strong relationship between SRS-2 and Vineland scores. However, other parent-report measures also included in the analysis to assess specific aspects of the ASD phenotype -restrictive and repetitive behaviours (RRB) and sensory atypicalities (SSP) – had a reduced level of association with parent-reported Vineland scores. This suggests that shared method variance between the SRS-2 and Vineland is unlikely to fully account for the results observed. Another concern relates to the observation that the SRS-2 taps into overlapping symptom constructs as the Vineland, and in particular social skills.

While this is certainly the case for the Socialisation domain, which shows the strongest association with SRS-2 scores, SRS-2 scores are also significantly associated with non-social adaptive skills (e.g. Daily Living Skills). In fact, regression coefficients for SRS-2 scores are equivalent for the Daily Living and Communication domain, suggesting a similar effect of ASD symptoms on adaptive behaviour across different domains of ‘real-world’ functioning.

The results also replicate previous findings in several key areas, including the expected profile of impaired adaptive functioning in individuals with ASD with largest impairments seen for Socialisation, followed by Daily living skills and Communication; age-related declines in adaptive functioning relative to age-matched peers in a standardisation sample; and a strong effect of IQ for adaptive behaviour (Kanne et al., 2011; Pugliese et al., 2015). Exploratory analyses also revealed a trend towards a curvilinear association between full-scale IQ and adaptive functioning. This may indicate that IQ-adaptive discrepancies become more pronounced with higher IQ, such that in high-IQ individuals adaptive skills are less commensurate with cognitive abilities. Although these effects were modest and only significant at trend level, they are in line with another recent study (Chatham et al., 2018), suggesting that cognitive ability does not fully explain impairments in adaptive functioning in ASD, and particularly in higher-ability individuals. It is also noteworthy that albeit significant due to the large sample studied, age had only a modest effect on adaptive scores.

Consistent with previous research (Klin et al., 2007; Kanne et al., 2011; Pugliese et al., 2015), most subjects (71% of the sample) demonstrated significant impairments in adaptive functioning relative to their IQ. Among those individuals with ASD with clinically significant ability-adaptive discrepancies (i.e. a discrepancy score of at least 1 *SD*), the analysis revealed age- and IQ-dependent effects, with older age and higher IQ being associated with larger FSIQ-adaptive functioning discrepancy scores. Specifically, the analysis on VABS scores showed that while higher FSIQ is associated with higher VABS

scores on the Daily Living domain and ABC (i.e. the linear effect of FSIQ), this relationship depends on FSIQ itself (i.e. it is lower at higher values; the quadratic effect). Overall, these findings suggest that the magnitude of deficits in real-life skills relative to an individual's level of IQ was increasingly more pronounced in older compared to younger individuals as well as in those with higher cognitive abilities. Importantly, the analysis confirmed that these age- and IQ-dependent effects uniquely contributed to variability in adaptive functioning.

There are limitations to the study. First, age-related declines in adaptive functioning relative to age-peers and a widening of an ability-adaptive discrepancy through later childhood, adolescence and into adulthood may be accounted for by differences in services or interventions received, which was not investigated in the present analysis. This is a complex issue however, since interventions may differ in the onset, length, intensity, quality and type of intervention received, and any of these factors may have affected variability in adaptive functioning. Second, the cross-sectional nature of the data leaves open possibilities for alternative interpretations. For example, it is not clear if the age-related differences observed reflect true effects or are due to sampling differences across different ages. Third, the majority of participants in the LEAP sample had an elevated IQ compared to the total population of individuals with ASD, of whom around 50% have an intellectual disability (Charman, 2015; Lai et al., 2014). Thus, the findings need to be replicated in a larger sample of lower ability individuals with ASD. Although it is a notable limitation of the representativeness of the current sample that in common with many studies we excluded individuals with ASD with severe intellectual disability, it is rare for experimental biomarker studies to include participants with an IQ below 75. Finally, the current study reports on adaptive function drawn from the individual differences approach taken in conventional DSM/ICD psychiatric nosology but did not consider functioning within a wider bio-psycho-social model. Recent work has adapted the WHO International Classification of Functioning

Disability and Health to develop ‘core sets’ specifically for ASD (Bölte et al., 2018). We also did not consider patient-nominated outcomes such as quality of life (van Heijst et al., 2015; Oakley et al., 2018).

Conclusion

Despite many individuals with ASD scoring well on standardised IQ tests and the expectation that this may translate into achieving positive outcomes, many individuals with ASD have difficulty coping in everyday life and are not able to fully capitalise upon their cognitive strengths to develop adaptive skills in real-world contexts. Thus, the term ‘high functioning autism’, sometimes used to refer to individuals with ASD without an intellectual disability (ID) is an inaccurate clinical descriptor when based solely on IQ, since adaptive functioning in the real-world can be considerably impaired even for the most ‘high functioning’ individual. Given that outcome, particularly for higher-ability individuals, is more related to adaptive behaviour skills than cognitive factors (Farley et al., 2009), identifying the impediments to adaptive skills acquisition has important clinical implications for interventions. According to the present findings, core social communication ASD symptoms seem to play a larger role in contributing to variability in adaptive functioning and ability-adaptive discrepancies in ASD than sensory and repetitive ASD symptoms and co-occurring psychiatric symptoms. The results suggest that the severity of ASD social communication symptoms constitutes a barrier to the development of more sophisticated adaptive functioning skills, respectively they depend on both, social communication abilities and intellectual functioning. Interventions targeting adaptive skills acquisition should therefore be tailored according to developmental stage, level of cognitive ability and take account of ASD symptom severity, in particular social-communicative abilities to better support individuals with ASD to live independently and navigate the social world. The strengths of the study include the large sample size, the broad range of ages and different

levels of cognitive functioning studied, and the use of multi-method, multi-informant instruments that capture *different* aspects of the ASD phenotype, as well a range of commonly associated psychiatric symptoms (ADHD, anxiety, depression). This extends previous studies significantly by comprehensively assessing adaptive functioning in a well-powered, well-characterised sample of individuals with ASD.

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Table 1 Sample characteristics ($N = 417$)

	<i>N</i>	Mean	<i>SD</i>	Range
Sex (males: females)	301:116	-	-	-
Age in years	417	16.89	(5.95)	6-31
ADOS CSS-SA	406	6.18	(2.65)	1-10
ADOS CSS-RRB	406	4.92	(2.78)	1-10
SRS-2	339	92.76	(30.38)	20-168
RBS-R	337	16.82	(14.12)	0-90
SSP	240	137.73	(27.32)	53-190
ADHD - Inattentiveness	342	4.63	(3.18)	0-9
ADHD - Hyperactivity/Impulsivity	342	2.92	(2.90)	0-9
DAWBA - anxiety	346	2.55	(1.31)	0-5
DAWBA - depression	318	0.92	(1.24)	0-5
VABS Socialisation	374	70.06	(16.44)	20-119
VABS Daily Living	373	72.40	(16.41)	25-131
VABS Communication	374	74.52	(17.22)	21-130
VABS ABC	371	70.27	(14.84)	20-121
Nonverbal IQ	410	97.48	(21.83)	44-150
Verbal IQ	406	95.66	(20.51)	41-160
Full-scale IQ	410	96.61	(20.27)	40-148

Note: *SD* = Standard Deviation; ABCADOS CSS-SA, RRB = Autism Diagnostic Observation Schedule Calibrated Severity Scores for Social Affect and Restricted and Repetitive Behaviours; SRS-2 = Social Responsiveness Scale – 2 raw score; RBS-R = Repetitive Behavior Scale – Revised; SSP = Short Sensory Profile; ADHD = DSM-5 ADHD rating scale; DAWBA = Development and Well-Being Assessment; VABS domain scores are standardised scores (age-normalised: $M = 100$, $SD = 15$); VABS ABC = VABS Adaptive Behavior Composite; IQ = Intelligence Quotient

Table 2 Linear mixed effects models for VABS domain scores and Adaptive Behavior Composite

Variable	Socialisation			Daily living			Communication			Adaptive Behavior Composite		
	<i>b</i> <i>SE (b)</i>	<i>z</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>z</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>z</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>z</i>	95% <i>CI</i>
Age	-1.13 (0.19)	-5.96*	[-1.50,-0.76]	-0.38 (0.19)	-1.99	[-0.76,-0.01]	-1.18 (0.18)	-6.60*	[-1.53,-0.83]	-0.96 (0.16)	-6.10*	[-1.27,-0.65]
Sex [†]		0.88			1.36			4.16			2.00	
FSIQ	0.14 (0.05)	2.80*	[0.04,0.23]	0.27 (0.05)	5.54*	[0.17,0.36]	0.30 (0.05)	6.32*	[0.21,0.39]	0.23 (0.04)	5.63*	[0.15,0.31]
ADOS CSS-SA	0.33 (0.39)	0.86	[-0.43,1.09]	0.32 (0.39)	0.84	[-0.43,1.08]	-0.10 (0.37)	-0.26	[-0.82,0.63]	0.19 (0.32)	0.60	[-0.44,0.82]
ADOS CSS-RRB	-0.04 (0.34)	-0.11	[-0.71,0.64]	-0.22 (0.34)	-0.63	[-0.89,0.46]	-0.02 (0.33)	-0.05	[-0.66,0.63]	-0.13 (0.28)	-0.45	[-0.69,0.43]
SRS-2	-0.24 (0.05)	-5.38*	[-0.33,-0.15]	-0.14 (0.05)	-3.03*	[-0.23,-0.05]	-0.14 (0.04)	-3.19*	[-0.23,-0.05]	-0.17 (0.04)	-4.59*	[-0.24,-0.10]
RBS-R	-0.15 (0.10)	-1.46	[-0.35,0.05]	-0.03 (0.10)	-0.26	[-0.23,0.18]	0.03 (0.10)	0.34	[-0.16,0.23]	-0.04 (0.09)	-0.49	[-0.21,0.13]
SSP	0.04 (0.05)	0.83	[-0.06,0.15]	0.05 (0.05)	0.91	[-0.05,0.15]	0.01 (0.05)	0.30	[-0.08,0.11]	0.04 (0.04)	0.93	[-0.04,0.13]
ADHD - Inattentiveness	0.68 (0.39)	1.74	[-0.09,1.45]	-0.22 (0.39)	-0.57	[-0.98,0.54]	-0.83 (0.38)	-2.20	[-1.57,-0.09]	-0.17 (0.32)	-0.52	[-0.80,0.47]
ADHD – Hyper/Impul.	-0.46 (0.43)	-1.08	[-1.30,0.38]	0.21 (0.43)	0.50	[-0.62,1.05]	0.18 (0.41)	0.43	[-0.63,0.98]	0.03 (0.35)	0.09	[-0.66,0.72]
DAWBA - Depression	-1.72 (2.13)	-0.81	[-5.90,2.45]	-1.32 (2.12)	-0.62	[-5.49,2.84]	-3.58 (2.05)	-1.74	[-7.60,0.44]	-2.33 (1.76)	-1.32	[-5.77,1.12]
DAWBA - Anxiety	0.44 (3.21)	0.14	[-5.85,6.74]	2.12 (3.20)	0.66	[-4.15,8.38]	2.47 (3.10)	0.80	[-3.61,8.55]	1.95 (2.65)	0.74	[-3.24,7.14]
Bosker/Snijders <i>R</i> ²	0.443			0.356			0.456			0.449		
ICC [‡]	.14			.22*			.06			.19*		

Note: *b* = regression coefficient, *SE(b)* = Standard Error of regression coefficient, *z* = z-statistic, 95% *CI* = 95% Confidence Interval of regression coefficient; *R*² = R-squared estimate; FSIQ = Full-scale IQ; ADOS CSS-SA, RRB = Autism Diagnostic Observation Schedule Calibrated Severity Scores for Social Affect and Restricted and Repetitive Behaviours; SRS-2 = Social Responsiveness Scale – 2; RBS-R = Repetitive Behavior Scale – Revised; SSP = Short Sensory Profile; ADHD = DSM-5 ADHD rating scale; DAWBA = Development and Well-Being Assessment; * *p* < .01

[†]ANOVA Main effect (F-statistic); [‡]ICC= Intra-class correlation coefficient (ratio of between-site variance to total variance)

Table 3 Multivariate Multiple Regression models for FSIQ-VABS discrepancy scores for individuals with a FSIQ-VABS ABC discrepancy

Variable	FSIQ-Socialisation			FSIQ-Daily living			FSIQ-Communication			FSIQ-ABC		
	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>
Age	1.07 (0.22)	4.79*	[0.63,1.51]	0.11 (0.23)	0.47	[-0.34,0.56]	1.04 (0.22)	4.80*	[0.61,1.46]	0.79 (0.17)	4.68*	[0.46,1.13]
Sex [†]		0.28			0.25			2.89			1.21	
FSIQ [‡]	0.72 (0.08)	-	-	0.64 (0.08)	-	-	0.55 (0.08)	-	-	0.65 (0.06)	-	-
ADOS CSS-SA	-0.35 (0.45)	-0.78	[-1.25,0.55]	-0.46 (0.46)	-1.00	[-1.38,0.45]	-0.05 (0.44)	-0.11	[-0.92,0.82]	-0.33 (0.34)	-0.95	[-1.01,0.35]
ADOS CSS-RRB	-0.21 (0.43)	-0.49	[-1.06,0.64]	0.84 (0.44)	1.92	[-0.03,1.70]	-0.35 (0.42)	-0.84	[-1.17,0.48]	0.11 (0.33)	0.33	[-0.54,0.76]
SRS-2	0.26 (0.06)	4.61*	[0.15,0.36]	0.13 (0.06)	2.34	[0.02,0.24]	0.13 (0.05)	2.46	[0.03,0.24]	0.17 (0.04)	4.02*	[0.09,0.25]
RBS-R	0.18 (0.13)	1.36	[-0.08,0.43]	0.10 (0.13)	0.74	[-0.16,0.35]	-0.01 (0.12)	-0.09	[-0.26,0.23]	0.08 (0.10)	0.77	[-0.12,0.27]
SSP	-0.08 (0.06)	-1.19	[-0.21,0.05]	-0.05 (0.07)	-0.79	[-0.18,0.08]	0.06 (0.06)	0.89	[-0.07,0.18]	-0.03 (0.05)	-0.51	[-0.12,0.07]
ADHD - Inattentiveness	-0.90 (0.48)	-1.87	[-1.85,0.05]	0.42 (0.49)	0.86	[-0.55,1.39]	0.11 (0.46)	0.23	[-0.81,1.03]	-0.06 (0.36)	-0.15	[-0.78,0.67]
ADHD – Hyper/Impul.	0.07 (0.55)	0.13	[-1.02,1.16]	-1.21 (0.56)	-2.16	[-2.31,-0.10]	0.40 (0.53)	0.76	[-0.65,1.46]	-0.29 (0.42)	-0.70	[-1.12,0.53]
DAWBA – Depression	3.67 (2.65)	1.39	[-1.58,8.92]	-1.02 (2.69)	-0.38	[-6.35,4.31]	3.68 (2.56)	1.44	[-1.39,8.75]	2.20 (2.01)	1.09	[-1.78,6.18]
DAWBA – Anxiety	1.12 (3.85)	0.29	[-6.52,8.75]	-2.44 (3.91)	-0.62	[-10.19,5.31]	-1.71 (3.72)	-0.46	[-9.08,5.67]	-1.12 (2.92)	-0.38	[-6.91,4.67]

Note: *b* = regression coefficient, *SE(b)* = Standard Error of regression coefficient, *z* = z-statistic, 95% *CI* = 95% Confidence Interval of regression coefficient; *R*² = unadjusted R-squared estimate; FSIQ = Full-scale IQ; ABC = Adaptive Behavior Composite; ADOS CSS-SA, RRB = Autism Diagnostic Observation Schedule Calibrated Severity Scores for Social Affect and Restricted and Repetitive Behaviours; SRS-2 = Social Responsiveness Scale – 2; RBS-R = Repetitive Behavior Scale – Revised; SSP = Short Sensory Profile; ADHD = DSM-5 ADHD rating scale; DAWBA = Development and Well-Being Assessment; * *p* < .01

[†]ANOVA Main effect (F-statistic); [‡]Regression coefficients may reflect mathematical coupling and are therefore reported for illustrative purposes only

Supplementary Materials

Measures - Autism Diagnostic Observation Schedule

Depending on an individual's language level and age, participants were administered one of several modules of the *Autism Diagnostic Observation Schedule* (ADOS-G; Lord et al., 2000; ADOS-2; Lord et al., 2012). Most participants received the ADOS-2 (Module 1: $N = 1$; Module 2: $N = 3$; Module 3: $N = 153$; Module 4: $N = 218$), while a minority of participants received the ADOS-G (Module 3: $N = 8$; Module 4: $N = 26$). Item scores for ADOS-G were first converted to ADOS-2 algorithm scores, which were then used to derive a Calibrated Severity Score (CSS). CSS provide a standardised ASD severity measure for the core symptom domains of Social Communication (i.e. Social Affect), and Restricted and Repetitive Behaviours (RRB), as well as an overall indicator of ASD severity (CSS Total). CSS are based on a 10-point severity metric, with higher scores indicating more severe ASD symptoms.

In those instances where ADOS CSS could not be computed because of missing ADOS-G or ADOS-2 item score data ($N = 19$; 5% of total observations), ADOS CSS were imputed by using a multiple imputation procedure with chained equations in STATA ('mi impute chained' in Stata15, StataCorp, 2017). Variables included in the imputation procedure, due to their high correlation with ADOS CSS, were ADOS-G Communication and Social Interaction Total scores for ADOS CSS Social Affect (Module 3 & 4: $r = .92$) and ADOS-G Stereotyped Behaviours and Restricted Interests Total scores for ADOS CSS RRB (Module 3: $r = .81$; Module 4: $r = .66$) and run for Module 3 and 4 separately. To satisfy the missing at random (MAR) assumption, site was included as an auxiliary variable in the model and a total of 30 imputations were run for each outcome variable.

Results - Characterisation of adaptive functioning

Across all VABS domains, individuals with ASD showed significant deficits in adaptive functioning, with the most impaired domain being Socialisation, followed by Daily Living and the least impaired domain being Communication (Table 1). Paired sample *t*-tests adopting a multiple comparison adjusted α -level of 0.017 (i.e. $0.05/3 = 0.017$) comparing each VABS domain were run. They confirmed that these were statistically significant differences of impairment, with the Socialisation domain being more impaired than Daily Living domain ($t(372) = 3.54, p = .0005, d = .18$) and Communication domain ($t(373) = 5.89, p = .8.617e-09, d = .30$). The Daily living domain was also more impaired than the Communication domain ($t(372) = 3.03, p = .003, d = .16$).

In addition, in individuals with ASD, all VABS domain and standard scores fell well below (i.e. around 2 *SDs*) the age-normed reference value of 100 ($SD = 15$; one-sample *t*-test: all p 's $< 4.036e-96$, Cohen's d from 1.5 to 2.0), highlighting the magnitude of adaptive functioning impairment in this sample compared to typically developing age-matched peers. Most VABS adaptive behaviour domain and ABC standard scores showed significant but weak negative correlations with age (at $p < .001$), with largest correlations seen for the Communication domain ($r = -.29, p < .0001$; Supplementary Table 1), followed by ABC standard scores ($r = -.21, p < .0001$) and the Socialisation domain ($r = -.19, p = .0002$).

- Supplementary Table 1 about here -

Since this study uses a cross-sectional design, any significant correlations with age could have be an artefact of IQ differences between the younger and the older participants ($N = 343$; $FSIQ \geq 75$), which may be related to differences in recruitment patterns or developmental changes in IQ. To rule out this possibility, the sample was divided by a median age split (Median = 16.3 years) and an independent sample *t*-test was performed to

test for FSIQ score differences between age groups. No significant IQ differences between age groups were observed ($M_{Young} = 102.2$, $SD_{Young} = 15.2$ vs. $M_{Old} = 104.4$, $SD_{Old} = 15.5$; $t(337) = 1.30$, $p = .193$, $d = .14$), confirming the robustness of the results above.

Overall, there were significant negative correlations between ASD symptom measures and VABS scores across most domain and standard scores ranging from weak to moderate (Supplementary Table 1; r from $-.19$ to $-.55$, all p 's $< .001$), with greater symptom severity associated with more impaired adaptive functioning. In contrast, for measures of associated psychiatric conditions of ADHD, anxiety and depression, the findings were more mixed. While ADHD symptoms of Inattentiveness and to a lesser degree Hyperactivity/Impulsivity showed significant negative correlations with VABS scores (r from $-.18$ to $-.33$, all p 's $< .001$), there were no significant associations between anxiety, depression and VABS standardised scores.

Supplementary References

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Supplementary Table 1 Correlations between VABS adaptive behaviour domain and standard scores, age, IQ, and clinical measures

	VABS Socialisation	VABS Daily Living	VABS Communication	VABS ABC
Age	-0.19*	-0.11	-0.29*	-0.21*
Full-scale IQ	0.38*	0.46*	0.53*	0.50*
ADOS CSS-SA	-0.19*	-0.16	-0.22*	-0.19*
ADOS CSS-RRB	-0.21*	-0.24*	-0.14	-0.21*
SRS-2	-0.55*	-0.47*	-0.32*	-0.49*
RBS-R	-0.44*	-0.36*	-0.20*	-0.36*
SSP	0.39*	0.38*	0.13	0.34*
ADHD - Inattentiveness	-0.29*	-0.33*	-0.23*	-0.31*
ADHD - Hyperactivity/Impulsivity	-0.25*	-0.18*	-0.10	-0.19*
DAWBA - Anxiety	-0.10	-0.07	0.03	-0.04
DAWBA - Depression	-0.07	-0.00	0.01	-0.02

Note: VABS ABC = Vineland-II Adaptive Behavior Composite; ADOS CSS-SA, RRB = Autism Diagnostic Observation Schedule Calibrated Severity Scores for Social Affect and Restricted and Repetitive Behaviours; SRS-2 = Social Responsiveness Scale – 2; RBS-R = Repetitive Behavior Scale – Revised; SSP = Short Sensory Profile; ADHD = DSM-5 ADHD rating scale; DAWBA = Development and Well-Being Assessment

* $p < 0.001$

Supplementary Table 2 Correlations between FSIQ-VABS discrepancy scores age, IQ, and clinical measures

	FSIQ-VABS Socialisation	FSIQ-VABS Daily Living	FSIQ-VABS Communication	FSIQ-VABS ABC
Age	0.13	0.05	0.23*	0.14
FSIQ†	0.22	0.23	0.19	0.34
ADOS CSS-SA	-0.02	-0.08	0.01	-0.06
ADOS CSS-RRB	0.08	0.11	0.01	0.07
SRS-2	0.28*	0.23*	0.07	0.21*
RBS-R	0.28*	0.23*	0.05	0.20
SSP	-0.27*	-0.29*	-0.05	-0.24
ADHD - Inattentiveness	0.05	0.10	-0.00	0.05
ADHD - Hyperactivity/Impulsivity	0.04	-0.02	-0.11	-0.04
DAWBA - Anxiety	0.10	0.08	0.01	0.06
DAWBA - Depression	0.10	0.04	0.04	0.06

Note: VABS ABC = Vineland-II Adaptive Behavior Composite; ADOS CSS-SA, RRB = Autism Diagnostic Observation Schedule Calibrated Severity Scores for Social Affect and Restricted and Repetitive Behaviours; FSIQ = Full-scale IQ; SRS-2 = Social Responsiveness Scale – 2; RBS-R = Repetitive Behavior Scale – Revised; SSP = Short Sensory Profile; ADHD = DSM-5 ADHD rating scale; DAWBA = Development and Well-Being Assessment

†Correlation coefficients adjusted following Oldham's method: $Corr \left[x - y, \frac{x+y}{2} \right] = \frac{s_x^2 - s_y^2}{\sqrt{(s_x^2 + s_y^2)^2 - 4r_{xy}^2 s_x^2 s_y^2}}$, where s_x^2 = Variance of FSIQ, s_y^2 = Variance of VABS score, r_{xy} = Correlation

between FSIQ and VABS score (see Supplementary Table 1); * p < 0.001

Supplementary Table 3 Multivariate Multiple Regression models for FSIQ-VABS discrepancy scores in the whole sample

Variable	FSIQ-Socialisation			FSIQ-Daily living			FSIQ-Communication			FSIQ-ABC		
	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>	<i>b</i> <i>SE (b)</i>	<i>t</i>	95% <i>CI</i>
Age	1.13 (0.20)	5.78*	[0.75,1.52]	0.50 (0.21)	2.42	[0.09,0.91]	1.14 (0.19)	6.14*	[0.77,1.51]	0.94 (0.16)	5.76*	[0.62,1.26]
Sex [†]		0.73			1.01			3.30			1.58	
FSIQ [‡]	0.88 (0.05)	-	-	0.76 (0.06)	-	-	0.71 (0.05)	-	-	0.79 (0.04)	-	-
ADOS CSS-SA	-0.43 (0.41)	-1.06	[-1.24,0.38]	-0.49 (0.43)	-1.14	[-1.33,0.36]	0.22 (0.39)	0.57	[-0.54,0.98]	-0.25 (0.34)	-0.74	[-0.92,0.42]
ADOS CSS-RRB	0.43 (0.35)	1.25	[-0.25,1.12]	0.97 (0.36)	2.66	[0.25,1.69]	-0.04 (0.33)	-0.12	[-0.69,0.61]	0.47 (0.29)	1.63	[-0.10,1.04]
SRS-2	0.25 (0.05)	5.02*	[0.15,0.35]	0.14 (0.05)	2.78*	[0.04,0.25]	0.14 (0.05)	2.95*	[0.05,0.23]	0.18 (0.04)	4.26*	[0.09,0.26]
RBS-R	0.19 (0.11)	1.71	[-0.03,0.41]	0.12 (0.12)	1.01	[-0.11,0.35]	-0.04 (0.11)	-0.35	[-0.24,0.17]	0.07 (0.09)	0.80	[-0.11,0.26]
SSP	-0.07 (0.06)	-1.29	[-0.18,0.04]	-0.10 (0.06)	-1.64	[-0.21,0.02]	-0.01 (0.05)	-0.13	[-0.11,0.10]	-0.06 (0.05)	-1.34	[-0.16,0.03]
ADHD - Inattentiveness	-0.51 (0.42)	-1.20	[-1.34,0.33]	0.49 (0.44)	1.09	[-0.39,1.36]	0.77 (0.40)	1.93	[-0.02,1.56]	0.31 (0.35)	0.87	[-0.39,1.00]
ADHD – Hyper/Impul.	0.07 (0.45)	0.15	[-0.83,0.96]	-0.82 (0.48)	-1.72	[-1.76,0.12]	-0.17 (0.43)	-0.40	[-1.02,0.67]	-0.40 (0.38)	-1.06	[-1.14,0.35]
DAWBA – Depression	1.44 (2.30)	0.63	[-3.10,5.98]	0.82 (2.42)	0.34	[-3.95,5.59]	3.35 (2.17)	1.54	[-0.95,7.64]	2.05 (1.92)	1.07	[-1.73,5.83]
DAWBA – Anxiety	-0.84 (3.49)	-0.24	[-7.74,6.05]	-2.57 (3.67)	-0.70	[-9.81,4.68]	-1.96 (3.30)	-0.59	[-8.48,4.57]	-2.11 (2.91)	-0.73	[-7.86,3.63]

Note: *b* = regression coefficient, *SE(b)* = Standard Error of regression coefficient, *z* = z-statistic, 95% *CI* = 95% Confidence Interval of regression coefficient; *R*² = unadjusted R-squared estimate; FSIQ = Full-scale IQ; ABC = Adaptive Behavior Composite; ADOS CSS-SA, RRB = Autism Diagnostic Observation Schedule Calibrated Severity Scores for Social Affect and Restricted and Repetitive Behaviours; SRS-2 = Social Responsiveness Scale – 2; RBS-R = Repetitive Behavior Scale – Revised; SSP = Short Sensory Profile; ADHD = DSM-5 ADHD rating scale; DAWBA = Development and Well-Being Assessment; * *p* < .01

[†]ANOVA Main effect (F-statistic); [‡]Regression coefficients may reflect mathematical coupling and are therefore reported for illustrative purposes only